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GEOLOGY.—*Factors in movements of the strand line.*[1] JOSEPH BARRELL, Yale University.

Within recent years new points of view in regard to present and recent movements of the sea level have been developed by a number of geologists. Johnson, Daly, Vaughan, and Davis have made important contributions. The writer has not entered upon this subject as a special problem for research but in the pursuit of other investigations has several times come into contact with it. But coming unexpectedly upon a subject from an angle is apt to give new suggestions and somewhat novel points of view. In the brief treatment which is necessary here, the purpose is to outline controlling factors, putting the emphasis upon those aspects which have presented themselves as somewhat novel. It is not the plan to demonstrate fully any single thesis, nor to treat in proper proportion all the composite factors.

The interpretation of composite rhythms. The movements of the strand show a rhythmic character. Smaller undulations are superposed upon larger oscillations. In the interpretation of these rhythms attention has generally been focused upon the marks of previous inroads of the sea, not upon the limits of its retreats, for these are now concealed. The record of a descending series measures only the sequence from the last maximum of a greater rhythm and does not in itself tell the present trend of the oscillations.

[1] Abstract of a paper presented before the Geological Society of Washington, March 24, 1915. To be published in full in the American Journal of Science.

Since the Oligocene the strand line has, on the whole, been retreating, the continents rising higher, the climates growing colder. In the Pleistocene there seems to have been a culmination of crustal and climatic oscillations, followed by a descending series. From these facts the ice age has been looked upon as past and the Quaternary revolution as closing, but at several times within the Pleistocene that view would have been better justified on the basis of a descending series than it is at the present moment.

Indications of oscillations given by subaqueous profiles. From a study of present shore action made some years previously as a basis for the development of "Some distinctions between marine and terrestrial conglomerates,"[2] it appeared that recent movements of the strand line may be elucidated by a method of study which analyzes the place and character of marine erosion and sedimentation. Both rivers and sea work with respect to a base level. Their first effort is to bring a profile to a graded slope and the nature of the work shows the direction, amount, and relative duration of recent changes of level. In order to study the water bottom the writer has made use of hydrographic charts of soundings. Profiles at right angles to the submarine contours have been obtained by projecting upon the given section all soundings within a certain width. A smoothed curve is then drawn through the soundings. Thus minor irregularities and possible errors tend to be eliminated. Such profiles show for many coasts that the present profile of wave-action is about 20 fathoms above a previous stand, this conclusion being in accord with the results reached by both Daly and Vaughan. Professor Daly has been following independently the same line of investigation and he states in a personal communication that he has reached the conclusion that effective wave-action stops much above the conventionally accepted 100-fathom line. With this conclusion the writer is in accord, and as an implication it appears that the outer flats of continental shelves are wave-built terraces constructed mostly from river detritus and laid down during lower stands of the sea. Drowned river val-

[2] Abstract, Bull. Geol. Society of America, **20**: 620. 1908.

leys point in the same direction, but the method of investigation here suggested is of independent value and should give much information for regions such as oceanic islands where the embayments do not give the depth nor duration of submergence.

Pliocene and Pleistocene marine terraces. A second line of investigation which has brought the writer to an intersection with the problem of recent movements was in connection with areal geologic work in southern New England. The topography in this region indicated a series of descending base levels. The methods applied in their study and the results have been published in abstract.[3] Each base level would be recorded in the interior by surfaces of subaerial denudation, on the seaward side by surfaces of marine planation. The latter were cut as benches across the harder rocks and are consequently better preserved than the former. A method of projected profiles, looking along the line of the shore, restores these ancient levels, gives the appearance of a wide flight of giant stairs, and hides the effects of later dissection. It is thought that the Goshen level, reaching to the height of 1380 feet in western Connecticut, dates from the earlier Pliocene. The terraces below descend by steps many miles broad and lying approximately at 1140, 920, 730, and 520 feet. The Pleistocene terraces below were, in comparison, very imperfectly developed, but a number can be traced. They show briefer periods of crustal rest and appear to represent an acceleration of the diastrophic rhythm in Pleistocene time. This crustal unrest is continued to the present, and the present is diastrophically as well as climatically a part of the Pleistocene.

The broader Tertiary rhythm shown by these wide terraces must have been complicated in the Pleistocene by special effects, such as the weight of the ice-sheets, the changes in volume of ocean water related to glaciation, and minor diastrophic movements. These complications, however, do not hide the facts which lead to the conclusion that on the Atlantic coast an abnormal crustal unrest beginning in the Pliocene has marked especially the entire Pleistocene period.

[3] Bull. Geol. Society of America, **24**: 688–696. 1913.

Turning attention next to the other side of the rhythm of movement, that of the record of submergences, we are led to the conclusion that the emergent phases of the oscillations are relatively rapid and brief, the submergent phase prolonged, and marked by a slowly rising level of the sea.

The combination of evidence from Maryland and New Jersey suggests strongly that certain early Pleistocene stages of cold climate and glaciation occurred when the ocean level stood at the higher parts of the phases of cyclic oscillation. The important point is that the development of the cold climates culminating in glaciation does not appear to have required a low level of the sea or high elevation of the land of this region. The evidence of the region marginal to glaciation leans toward the view that the amount of water abstracted for the formation of the ice-sheets was not a major factor in the control of Pleistocene sea levels. It would seem necessarily to have been an important factor, but the diastrophic rhythm continuing with accelerated movement from the Pliocene constituted apparently a factor of more control.

Post-glacial emergent cycle marginal to the glaciated areas. A third line of investigation is that connected with the Strength of the Crust, a subject now in progress of publication in the *Journal of Geology*. If the hypothesis set forth there is valid—that a thick and strong lithosphere rests upon a thick zone of comparative weakness, an asthenosphere—then the weight of a continental ice-sheet should tend to depress the crust into this weak zone. As this subcrustal zone is not a fluid it can not transmit the excess pressures to unlimited distances. Broad and low pressure ridges would therefore tend to be raised beyond the limits of the ice-sheets. With removal of the ice-load the pressure ridges might rise at first with the central part and then subside.

This theory has been applied to the data regarding water levels during the retreat of the ice, as given by Woodworth for the Champlain and Hudson valleys.[4] The data permit the

[4] New York State Education Department, Bull, **84**. 1905.

determination of the sea level in latitude 40° for each stage of the ice retreat. This represents the movements in a belt beyond the terminal moraines. The figures obtained indicate that the Coastal Plain was higher than at present and rising, the sea sinking, during the retreat of the ice. These effects are of an opposite character to that produced by the addition of water to the ocean during deglaciation.

This argument by itself rests upon a structure of hypothesis and carries but little weight, but independent lines of evidence pointing in this direction will now be considered. Analysis of the data obtained from borings in the channels of the Hudson shows that a cycle of emergence and subsidence has occurred since the retreat of the ice, but not over 200 feet as a maximum above present level. Evidence that a minor cycle of emergence and submergence has occurred along the shores of southern New England and the South is also found. The evidence for a rapid cycle of post-glacial emergence of considerable amount, involving a tract beyond the limits of glaciation, now drowned, is perhaps best given by the distribution of plants along the Atlantic shore from New Jersey to Newfoundland. From the work of Britton, Hollick, and especially Fernald, it is shown that 118 species of plants belonging to the southern Coastal Plain floras are known from widely isolated outlying stations along the coastal strip of New England and the Maritime Provinces. Newfoundland, however, furnishes the most remarkable and convincing evidence. Fernald shows that neither winds nor currents nor migrating birds can be competently invoked in explanation. A remaining hypothesis is that for a time after the last retreat of the ice the Coastal Plain stood higher, margined the continent as far at least as Labrador, and permitted the spread of the Coastal Plain flora. The character of the flora suggests that the migration to the present isolated localities must have taken place during a period of climate even warmer than the present and therefore at a time after the ice-sheets had given up their water. The hypothesis that the emergence was due to withdrawal of water during glaciation must therefore be ruled out.

Somewhat similar evidence is found, on the shores of northwestern Europe, of land emergence above the present level involving regions beyond the limits of glaciation and occurring in a warm stage following the retreat of the ice. Submergence to a level a little below the present stand of the sea then took place. This is presented in comprehensive form by W. B. Wright, of the Geological Survey of Ireland, in his recent book on the *Quaternary Ice Age*. Wright considers the breadth of this movement as indicative of a general lowering of sea level, possibly by a recrudescence of the Antarctic ice-sheets, but either of two other hypotheses is preferable.

One of these is that the movements represent a diastrophic cycle entirely unrelated to glaciation. The other hypothesis is that the weight of the ice-sheets caused crustal depression directly below the load, but moderate elevation in a wide zone beyond. Upon the removal of the ice-load the first isostatic upwarping carried up higher this marginal upwarped zone with it. This broad regional movement carried it up to a level where it became unstable and a slow settling-back occurred as an after-effect. The close association of these movements with the close of glaciation appears to favor a genetic connection with deglaciation.

Possible effects of radial shrinkage. Calculations made by the writer as to the quantitative effect of earth shrinkage in producing an increased speed of rotation, and consequently a rise of ocean waters toward the equator and a depression in the polar regions, suggest that it may be a very real factor. A shrinkage of a mile, if taken up wholly by adjustment of ocean level and not by internal earth adjustment (a supposition which can be true to only a limited degree), would raise the water level at the equator about 35 feet and depress it at the poles about 60 feet.

Such great folding and thrusting movements as have occurred in the later Tertiary suggest that earth shrinkage is an important factor. Schuchert has called attention to the greater persistence of equatorial epeiric seas and the readvance of waters more frequently from lower toward higher latitudes. It is pos-

sible also that a slight change in slope of the sea level at the time that river courses were established on a newly emerged coastal plain may be at least a partial cause of the southward deflections of rivers which were established along the Atlantic margin in late Tertiary time.

Conclusions. First, we must recognize the special factors connected with Pleistocene climates. These consist in the abstraction of vast quantities of ocean water during the development of the ice-sheets; the direct depression under the load of ice; a possible compensatory elevation in a broad zone beyond; a deferred, intermittent, and possibly oscillatory readjustment upon the removal of the burden of ice.

But these factors must not be used alone. The second group of causes includes the isostatic factors. They tend to maintain the equilibrium of large sections of the crust, affect the whole ocean level, and locally warp the lands, but do not involve earth shrinkage. The general rise of lands which has marked the later geologic times may most probably be placed in this category. The movements are due either to changes of external load or to changes in crustal density. Continental rejuvenation is the chief effect, but they include a possible enlargement or deepening of portions of the ocean basins.

The third group of causes is thought to be found in great compressive movements in the lithosphere which seem to be due in turn to a shrinkage of the centrosphere. Locally they may work against isostasy, more broadly they may start isostatic movements. As their ultimate expression is in mountain building along lines of weakness, they may be classed as orogenic causes.

Fourth are the planation factors, working in opposition to isostasy. They tend to erode the lands, fill the seas with sediment, and raise their surface level. The combination of isostatic and compressive forces has operated through geologic time. The causes are complex and the result is seen in the composite diastrophic rhythms.

To sift apart the factors comprehensive investigations must be prosecuted over different parts of the earth. The sequence

and amount of oscillations in the tropics must be linked to those of higher latitudes. Changes of sea level must be separated from local changes in the level of the crust. Multiple working hypotheses must be tested by the application of new and significant facts.

BOTANY.—**Merope angulata, *a salt-tolerant plant related to Citrus, from the Malay Archipelago.*** WALTER T. SWINGLE, Bureau of Plant Industry.

In the course of a survey of the wild relatives of the commonly cultivated citrous fruits, in the hope of finding new material for use in breeding, the writer was struck by accounts of a curious thick-leaved plant said to grow in tidal swamps in the Malay Archipelago at Noessa Kambangan, in southern Java, where it is called "kigerukkan." A search for descriptions has revealed a curious and involved nomenclatorial history, and a surprising lack of information as to the occurrence, nature, and possible economic value of this curious salt-tolerant plant. As early as 1801 it was described by Willdenow as *Citrus angulata*, with a citation of Rumphius' illustration of *Limonellus angulosus* in the Herbarium Amboinense (1741). In 1834 Wight and Arnott noted that the *Citrus angulata* of Willdenow was undoubtedly a Limonia, and Miquel later (1859) made the transfer as *Limonia angulosa*. In 1872 Kurz described this same plant as a new species under the name *Atalantia longispina*. Two years later he decided to create a genus, Gonocitrus, for the *Citrus angulata* of Willdenow, making his *Atalantia longispina* a synonym. In 1875 Hooker described the plant as *Paramignya longispina;* and in 1876 Kurz abandoned his genus Gonocitrus and transferred the *Citrus angulata* of Willdenow to Paramignya as *P. angulata*.

The nomenclatorial vicissitudes outlined above, however, tell only half the story!

In 1825 Blume created a new genus, Sclerostylis, to receive five species, regarded by him as new. Among them was the kigerukkan, which received the name *S. spinosa*. Although it is the first species listed by Blume, it cannot properly be con-

sidered the type of the genus. The name *Sclerostylis*, meaning hard style, must of course have applied to some species the styles of which were seen, whereas the type specimen of *Sclerostylis spinosa* has no flowers,[1] and the original description does not describe the flowers. Very probably Blume had only a single specimen of this plant from which to draw his description of the species. He had, however, flowering specimens of some, if not all, of his other species of Sclerostylis, now considered as belonging to Glycosmis, which have very short, thick styles that might easily have given occasion for the generic name. Material of *S. trifoliata* and *S. lanceolata* in the herbarium of the Muséum in Paris, labeled in Blume's hand, shows styles characteristic of Glycosmis and suggestive of the name Sclerostylis.

Finally, characteristically spiny material from the type locality (it should be noted that the other four species of Blume's Sclerostylis are inermous) shows the plant in question to be very different from Blume's genus in flower and especially in style characters.

Sprengel, in 1827, referred the *Sclerostylis spinosa* of Blume to the genus Limonia, and Dietrich in 1840 referred it to Glycosmis. In 1846 Roemer created a new monotypic genus, Merope, based on Blume's *Sclerostylis spinosa*. There is every reason to believe that Roemer did not see actual specimens of the plant, but drew the characters of his new genus exclusively from Blume's description. In 1912 Koorders[2] records this plant from Noessa Kambangan under the name *Atalantia spinosa*, giving "Hook., Index Kew. II. 849" as authority.[3]

A photograph of Blume's original type specimen at Leiden, obtained through the kindness of Dr. Th. Valeton, and a subsequent study of the specimen itself show beyond question that the *Sclerostylis spinosa* of Blume is the same as Willdenow's

[1] "Comme vous voyez le spec'men (l'original de *Sclerostylis spinosa* de Blume) n'a ni fleurs ni fruits." Valeton, Th. Letter dated Leiden, 10 October, 1910. In February, 1912, I had an opportunity of seeing the specimen myself in the Rijks Herbarium at Leiden.

[2] Exkursionsfl. Jav. **2**: 427.

[3] The reference in Kew Index under Sc'erostylis is as follows: "*spinosa* Blume, Bijdr. 134 (Atlantiae sp.)"

Citrus angulata. Under the name *Paramignya angulata* Kurz, Valeton in 1912[4] published a Latin description of this plant, accompanied by an excellent figure, giving fruits and flowers. Here, as a result of a suggestion made by the writer to Dr. Valeton in 1909, attention is first called to the identity of *Sclerostylis spinosa* and *Citrus angulata.* At the request of the writer a native collector was sent by Dr. Valeton to Noessa Kambangan on the south side of Java in 1910 and he succeeded in securing specimens of the kigerukkan and later on a considerable quantity of viable seeds.

Fig. 1. *Merope angulata.* Flowering branch. Scale one-half.

A study of these specimens and of living plants growing in the greenhouses of the U. S. Department of Agriculture at Washington, D. C., has convinced the writer that this plant cannot be referred to Paramignya but constitutes a distinct genus (figs. 1 and 2). Since Sclerostylis must be considered a synonym of Glycosmis, as shown above, the oldest available name for this plant is Roemer's Merope. This genus differs rather widely from any other plant in the subfamily Citratae, but is doubtless most nearly related to Paramignya and Lavanga, which also have fruits lacking in pulp vesicles. It differs from Paramignya in the character of the seeds, which are very long and flattened, in the triquetrous fruit (see fig. 2), the paired spines, the simple, short petiole (not long and twisted), and the thick, leathery leaves. It differs from Lavanga in the simple (not trifoliate) leaves, the simple, short petiole, and the straight (not curved) spines.

[4] Icones Bogorienses, **4**: 159–161. *pl. 348.* 1912.

The name of the kigerukkan, the only species known in this genus, becomes:

Merope angulata (Willd.) Swingle, comb. nov.[5]
Citrus angulata Willd. Sp. Pl., ed. 4, **3**[2]: 1426. 1801.
Sclerostylis spinosa Blume, Bijdr. Fl. Ned. Ind. **1**: 134. 1825.
Limonia spinosa Spreng. Syst. Veg., ed. 16, **4**[2]: 162. 1827.
Glycosmis spinosa Dietr. Syn. Pl. **2**: 1409. 1840.
Merope spinosa Roem. Syn. Mon. Hesp. **1**: 44. 1846.
Limonia angulosa Wight & Arnott; Miq. Fl. Ind. Bat. **1**[2]: 521. 1859.
Atalantia longispina Kurz, Journ. As. Soc. Bengal, **41**[2]: 295. 1872.
Gonocitrus angulatus Kurz, Journ. As. Soc. Bengal, **42**[2]: 228, *pl. 18*. 1874.
Paramignya longispina Hook. f. Fl. Brit. Ind. **1**: 511. 1875.
Paramignya angulata Kurz, Journ. As. Soc. Bengal, **44**[2]: 135. 1876.
Atalantia spinosa Hook. f. Index Kew. **4**: 849. 1895. (vide Koorders, Exkursionsfl. Jav. **2**: 427. 1912.)

Leaves coriaceous, inconspicuously veined, alternate; petioles simple. Twigs with very strong spines, often in pairs. Flowers borne singly or in pairs (rarely in few-flowered clusters) in the axils of the leaves; ovary stalked on a rather tall disk, 3–5-celled, with 2–4 pendulous ovules in each cell; stamens 10, free; anthers linear oblong. Fruits strongly angled, triangular in cross section; cells filled with a sticky mucilaginous fluid (without true pulp vesicles); seeds very large, flattened, reniform, caudate at the tip where attached. Cotyledons in germination aerial, not increasing in size; first foliage leaves alternate, broadly ovate.

A large shrub or small tree (not a climbing shrub), growing on the seashore in tidal forests or mangrove swamps from the mouth of the Ganges to the Moluccas.

MEROPE RESISTANT TO SOIL SALINITY

This plant, which has not received the attention it merits, either from botanists or horticulturists, was discovered in the Moluccas and has since been found in Java, at Malacca, in upper Tenasserim and lower Pegu (Burma), and in the Sunderbuns (the mouth of the Ganges in India). These regions represent a range of nearly 3000 miles, and it will doubtless be found to be widely distributed throughout the Malay Archipelago. It is likely to have escaped most collectors, however, because of its restriction to inaccessible coastal swamps.

The fact that *Merope angulata* grows only along the seashore

[5] The following pre-Linnaean name is referable to this species: *Limonellus angulosus* Rumph. Herb. Amboin. **2**: 110. *pl. 32*. 1741.

in mangrove swamps and tidal forests would naturally lead us to expect that it possesses high powers of "alkali resistance," since sea water contains over 3 per cent of dissolved salts and the mangrove and other plants growing in the mangrove swamps are able to withstand large quantities of dissolved salts in the

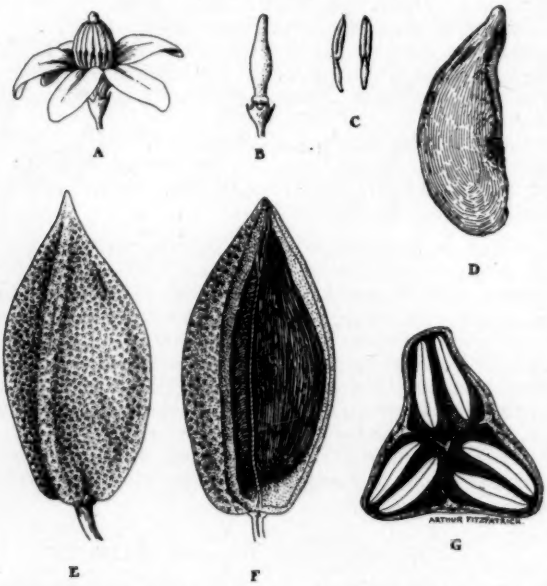

Fig. 2. *Merope angulata*. *A*, flower; *B*, pistil; *C*, stamens; *D*, seed; *E*, fruit; *F*, longitudinal section of fruit; *G*, cross section of fruit. *A–C*, scale 1.5 ; *D–G* natural size.

substratum. Experiments carried on with seedling plants in the greenhouses of the Department of Agriculture at Washington have shown that it is indeed very resistant to salt. One plant which was watered exclusively with a normal salt solution showed no ill effects for two months. The treatment was continued and the plant finally died, the soil containing at the time of its death 1.34 per cent salt (computed from readings by electrolytic bridge). Another plant was given 1.5 oz. normal

salt solution every fourth day (ordinary water being used in addition for any further moisture needed by the plant) from August 31, 1914, to January 20, 1915. At this latter date the foliage was yellowing and the roots were beginning to decay. Other plants of this species, however, which were given small amounts of normal salt solution from time to time, actually made better growth than those not receiving any salt.

POSSIBLE UTILIZATION OF KIGERUKKAN FOR STOCKS

When we remember that the orange is one of the most sensitive to alkali among the fruit trees, it can readily be seen that *Merope angulata* is a plant of decided interest for trial as a stock for other citrous plants, and experiments are now being carried on under greenhouse and field conditions to determine whether it can be so used. So far Citrus has not been grafted successfully on this stock; but a seedling kigerukkan grafted on a seedling grapefruit grew rapidly and after some months flowered, having developed a strong swelling at the point of union of the stock and scion in the meantime. It is therefore hoped that reciprocal grafting of the kigerukkan and the cultivated species of Citrus will ultimately be successful.

ZOOLOGY.—*The relationship between phylogenetic specialization and temperature in the recent crinoids.*[1] AUSTIN H. CLARK, National Museum.

In a previous paper[2] I discussed the relationship between phylogenetic specialization and bathymetrical distribution in the recent crinoids. In the present paper I shall consider in the same way the relationship between phylogenetic specialization and the temperature of the habitat.

Unfortunately temperature records for the crinoids are comparatively few, and for many of the families very unsatisfactory; yet, incomplete as they are, they bring out certain features which are not without interest.

[1] Published by permission of the Secretary of the Smithsonian Institution.
[2] Journ. Wash. Acad. Sci. 5: 309–317, May 4, 1915.

The frequency of the characters in the contrasted pairs (which are the same as those described in the preceding paper) at different temperatures are as follows; as before, the columns headed "1" represent the more primitive characters, those headed "2" the more specialized.

TABLE 1

Degrees Fahrenheit	*Calyx*		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
80–75	2	8	1	5	5	5	6	8	5	5	1	1
75–70	12	18	8	11	7	9	14	20	14	6	1	3
70–65	10	13	5	8	5	7	11	14	10	5	1	2
65–60	10	13	5	8	5	7	11	14	10	5	1	2
60–55	10	13	5	8	5	7	12	14	10	5	1	2
55–50	10	13	5	8	5	7	12	14	10	5	1	2
50–45	10	14	5	8	4	7	11	15	10	5	1	2
45–40	19	19	11	9	9	7	19	16	15	5	1	3
40–35	28	30	20	16	12	10	30	20	23	7	1	5
35–30	10	18	11	9	7	7	17	11	13	4	1	3
30–25	7	14	5	8	2	7	7	10	6	4	1	1

Expressed as percentages of the whole number in each category these figures are as follows:

TABLE 2

Degrees Fahrenheit	*Calyx*		*Column*		*Disk*		*Arms*		*Pinnules*		*General*	
	1	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
80–75	3	12	2	12	18	18	8	12	14	14	14	14
75–70	18	26	19	26	25	32	22	32	40	17	14	43
70–65	15	19	12	19	18	25	17	22	29	14	14	29
65–60	15	19	12	19	18	25	17	22	29	14	14	29
60–55	15	19	12	19	18	25	19	22	29	14	14	29
55–50	15	19	12	19	18	25	19	22	29	14	14	29
50–45	15	21	12	19	14	25	17	24	29	14	14	29
45–40	28	28	26	21	32	25	30	25	43	14	14	43
40–35	41	44	48	38	43	36	48	32	66	20	14	71
35–30	15	26	26	21	25	25	27	17	37	11	14	43
30–25	10	21	12	19	7	25	11	16	17	11	14	14

The average for all the columns headed "1" and for all of those headed "2" with and without the column headed "General," are as follows:

TABLE 3

Degrees Fahrenheit	Average, including the figures under the heading "General"		Excess		Average, without the figures under the heading "General"		Excess	
	1	2	1	2	1	2	1	2
80–75	10	14	– 4		9	14	– 5	
75–70	23	29	– 6		25	27	– 2	
70–65	17	21	– 4		18	20	– 2	
65–60	17	21	– 4		18	20	– 2	
60–55	18	21	– 3		18	20	– 2	
55–50	18	21	– 3		18	20	– 2	
50–45	17	22	– 5		18	21	– 3	
45–40	29	26	3	–	32	23	9	–
40–35	43	40	3	–	49	34	15	–
35–30	24	24	0	–	26	20	6	–
30–25	12	18	– 6		12	18	– 6	

Plotting the averages of all the less specialized (1) and the more specialized (2) characters with and without the averages under the heading "General" (fig. 1), we find that the more

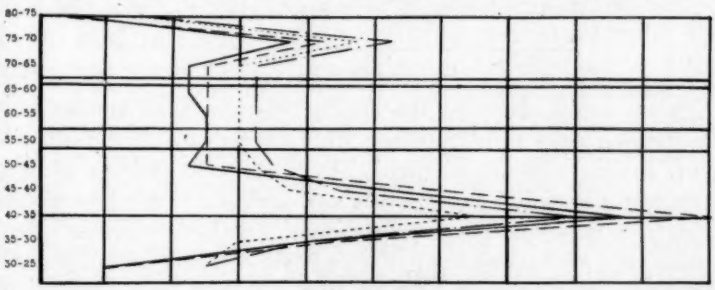

Fig. 1.

specialized characters predominate above 45°, and the less specialized below, down to 30°–25°, where the more specialized are again in the majority.

Plotting the excess of the more primitive (1) or of the more specialized (2) at different depths (fig. 2), we find that the more specialized predominate above 45°, and the more primitive between 45° and 30°, while below 30° the more specialized again predominate.

Within the optimum temperature range (55°–65°) we find a region of conservative phylogenetic advance, where the specialized characters, though predominant over the primitive, are not markedly so. The greatest predominance of specialized over primitive characters occurs equally in very warm and in very cold water, representing an acceleration of phylogenetic degeneration induced by phylogenetically unfavorable conditions.

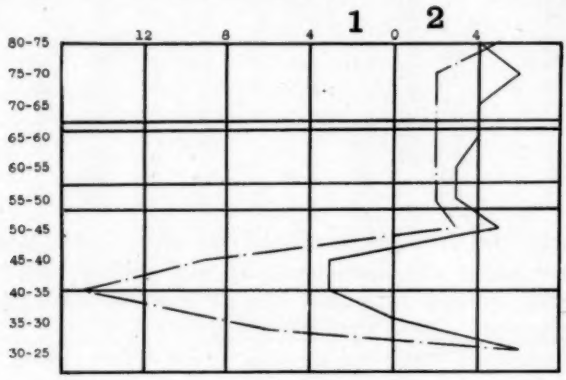

Fig. 2.

A statistical study of the crinoid characters on the basis of contrasted pairs thus bears out what I wrote in 1914 (Bull. No. 294, Institut Océanographique, Monaco): "Les espèces de l'eau très froide ressemblent pour cela aux espèces de l'eau très chaude par la possession d'une construction fondamentalement aberrante, car elles conservent et exagèrent certains caractères très primitifs, mais en même temps elles montrent une condition de développement très grande le long de lignes differentes. . . . Quelque extraordinaire que cela paraisse, dans tout ce grand développement les comatules de l'eau la plus froide se mettent d'accord plus intimement avec les espèces d'eau très chaude, qui appartiennent toutes à l'autre sous-ordre Oligophréata, qu'avec aucune des espèces des eaux intermédiares."

ENTOMOLOGY.—*A new genus of scolytoid beetles.*[1] A. D. HOPKINS, Bureau of Entomology.

There is in North America a group of beetles which inhabits the young cones and, in rare cases, the twigs or shoots of different species of Pinus. A representative of this group has been in the Fitch collection since 1850; another in the Hubbard and Schwarz collection since 1877; two species in Dr. W. H. Harrington's collection, Ottawa, Canada, since 1885; one species in the collection of Dr. J. Hamilton, Allegheny, Pa., since 1893; and during the past thirteen years many species have been added to the Forest Insect Collection of the Bureau of Entomology, in the U. S. National Museum. It has been found that some of the species are exceedingly common and often so destructive to the young cones of *Pinus strobus* in the East, *Pinus scopulorum* in the Rocky Mountain region, and *Pinus ponderosa* and *Pinus lambertiana* on the Pacific Slope, as to reduce the crop of seed fifty per cent or more below the normal during a single year. The species which inhabits the cones of *Pinus strobus* was described by Mr. E. A. Schwarz[2] as *Pityophthorus coniperda*.

The first reference to the habits of a representative of the group was published by A. S. Packard in the fifth report of the U. S. Entomological Commission, 1890, page 810, under the name *Dryocoetes affaber* Mann., and later Dr. Harrington[3] and Dr. Hamilton[4] published notes under the names *Dryocoetes affaber*, *D. autographus*, and *Pityophthorus coniperda*.

The other species, while recognized by the writer as new and as representing an undescribed genus, have not been described, because it was intended to include them in one of the parts of a monograph.[5]

[1] Contribution from the Branch of Forest Insects, Bureau of Entomology U. S. Department of Agriculture.

[2] Proc. Entom. Soc. Washington, **3**: 143–145. March 28, 1895

[3] Canad. Entom. **23**: 26–27. 1891. Also, Ibid. **34**: 72–73. 1902.

[4] Ibid. **25**: 279. 1893.

[5] Contributions toward a monograph of the scolytoid beetles, of which have been published: Tech. Series No. 17, Part I, 1909, and Part II, 1915, Bureau of Entomology, U S. Dept. Agric.; Proc. U. S. National Museum, Vol. 48, pp. 115–136, 1914; and Report 99, Office of the Secretary, U. S. Dept. Agric., 1915.

A bulletin (No. 243) of the U. S. Department of Agriculture is now in press giving the results of investigations on the habits and seasonal history of two of the undescribed species, which renders it necessary to publish these brief descriptions without further delay.

Conophthorus Hopk., gen. nov.

(Order *Coleoptera*, Superfamily *Scolytoidea*)

Pronotum with sides broadly rounded from near base to apex, slightly constricted beyond middle with the base margined; antennal club compressed, not thickened at base; abdominal sternite 7 with posterior margin procurved; pygidium vertical when in contact with posterior margin of sternite; pronotal rugosities extending toward or to lateral margin; tarsi with joint 5 not as long as joints 1 to 4 united; antennal club with three sutures on anterior and two on posterior face, sutures 1 and 2 without septum; eyes acutely emarginate.

Type of genus, *Pityophthorus coniperda* Schwarz, from Marquette, Michigan, Hubbard and Schwarz, collectors. Type in U. S. National Museum.

The genus Conophthorus is at once distinguished from Pityophthorus Eichh. by the absence of sutural septa in the antennal club.

SYNOPSIS

Elytral declivity with striae 1, 2 and 3 punctured; interspace 3 smooth. Division I.

Elytral declivity with stria 1 not punctured, 2 and 3 approximate and faintly punctured; interspace 3 rarely without granules. . . Division II.

DIVISION I

Head, prothorax, base of elytra, and ventral area dark; remainder of elytra red. Trinidad, Fort Garland, and Buena Vista, Colorado and Las Vegas, New Mexico, in cones of *Pinus edulis*. Length, 1.25–2.75 mm. Length, female type, 2.65 mm.; Las Vegas Hot Springs, New Mexico, on *Pinus edulis*, August 13, 1901, Barber and Schwarz, collectors. Type, Cat. No. 7472, U. S. N. M. . . . **C. edulis**, sp. nov.

DIVISION II

Elytra with strial and interspacial punctures equal or subequal in size and density on dorsal and lateral areas. . . . . Subdivision A.

Elytra with strial and interspacial punctures unequal in size and density, those of the interspaces smaller and sparsely placed, especially on the dorsal area. . . . . Subdivision B.

SUBDIVISION A

Elytral punctures fine, not impressed.
Black, shining; declivity with interspaces 1 granulate. Norfolk, Virginia, probably in cones of *Pinus taeda*. Length, type, 2.70 mm., (head missing); Hubbard and Schwarz Collection; Fortress Monroe, Virginia. Type, Cat. No. 7473, U. S. N. M.
Section a1; **C. taedae**, sp. nov.
Elytral punctures coarse, impressed.....Section a2.

SECTION a2

Interspaces 3 of elytral declivity with distinct granules, the declivity not strongly impressed.....Subsection b1.
Interspaces 3 of the elytral declivity without granules, or obscure.....
Subsection b2.

SUBSECTION b1

Elytra with strial punctures confused on dorsal area.....Series c1.
Elytra with strial punctures in obscure to distinct rows on dorsal area.
Series c2.

Series c1

Declivity with interspace 1 granulate:
Light to dark brown, West Virginia, in cones of *Pinus virginiana*. Length 2.70–3.05 mm. Length, female type, 2.70 mm.; Huttonsville, West Virginia, in *Pinus virginiana*, September 20, 1910, author, collector; Hopk. U. S., No. 8644a. Type, Cat. No. 7482, U. S. N. M.....**C. virginianae**, sp. nov.
Dull black. Maine, New Hampshire, Ontario, Canada, in cones and shoots of *Pinus resinosa*. Length, 2.75–3.25 mm. Length, female type, 3.15 mm.; in cones of red pine; Harrington Collection. Type, Cat. No. 7483, U. S. N. M.....**C. resinosae**, sp. nov.

Series c2

Declivity with interspaces 1 smooth, 3 granulate.
Pronotum dark, elytra reddish. Oregon, in cones of *Pinus ponderosa*. Length, 3.50–3.85 mm. Length, female type, 3.62 mm.; Ashland, Oregon, in *Pinus ponderosa*, May 29, 1913, P. D. Sergent, collector; Hopk. U. S., No. 10807a. Type, Cat. No. 7479, U. S. N. M.....**C. ponderosae**, sp. nov.

SUBSECTION b2

Elytral declivity not strongly impressed.
Pronotum dark; elytra reddish brown; front broad. Colorado, New Mexico, and Arizona, in cones of *Pinus scopulorum*. Length, 3.2–3.55 mm. Length, female type, 3.55 mm.; Flagstaff, Arizona, in *Pinus ponderosa*, May 26, 1904, author, collector; Hopk. U. S., No. 2740b. Type, Cat. No. 7480, U. S. N. M.
C. scopulorum, sp. nov.

Elytral declivity strongly impressed.

Pronotum dark; elytra dark reddish. Chiricahua Mountains, Arizona, in cones of *Pinus apachecae* (?) Length, 3.50–3.90 mm. Length, male type, 3.90 mm.; Chiricahua Mountains, June 6, Hubbard and Schwarz Collection. Type, Cat. No. 7484, U. S. N. M. ..... **C. apachecae,** sp. nov.

SUBDIVISION B

Elytra with strial punctures in obscure rows on lateral area ..... Section a3.

Elytra with strial punctures in distinct rows on lateral area ..... Section a4.

SECTION a3

Pronotum with punctures of posterior area fine ..... Subsection b3.

Pronotum with punctures of posterior area coarse ..... Subsection b4.

SUBSECTION b3

Punctures of elytra fine, obscure and sparse ..... Series c3.

Punctures of elytra distinct, those of the striae rather dense ..... Series c4.

Series c3

Declivity with interspace 1 obscurely granulate.

Black; length 3 mm. Fitch collection ..... **C. clunicus,** sp. nov.

Series c4

Declivity with interspaces 1 granulate; pubescence moderately long, erect.

Black, shining. front; narrow. Michigan, Ontario, Canada, New Hampshire, Massachusetts, Maine, Rhode Island, and Virginia, in cones and twigs of *Pinus strobus.* Length 2.50–2.90 mm. **C. coniperda** Schwarz.

Black, shining, front broad. Monterey County and Pacific Grove, California, in cones of *Pinus radiata.* Length 2.40–3.60 mm. Length, female type, 3.45 mm.; Pacific Grove, California. in *Pinus radiata,* November 14, 1913, J. M. Miller, collector; Hopk. U. S., No. 10861a. Type, Cat. No. 7481, U. S. N. M. **C. radiatae,** sp. nov.

Declivity with interspace 1 smooth, except toward apex, pubescence long.

Blackish brown, shining. Newport, Oregon, in cones of *Pinus contorta.* Length, female type, 3.10 mm.; Newport, Oregon, in *Pinus contorta,* April 30, 1899, author, collector; Hopk. U. S., No. 88. Type, Cat. No. 7476, U. S. N. M. . . . **C. contortae,** sp. nov.

Pronotum black; elytra black to reddish brown. Priest River, Idaho, and Cowitche Lake, Canada, in cones of *Pinus monticola.* Length 2.95–3.45 mm. Length, female type, 3.45 mm.; Priest River, Idaho, in *Pinus monticola,* October 19, 1906, R. L. Fromme, collector; Hopk. U. S., No. 6541a. Type, Cat. No. 7477, U. S. N. M. **C. monticolae,** sp. nov.

SUBSECTION b4

Elytra with punctures of dorsal area fine, not impressed.

Declivity with interspaces 1 smooth; black shining. Ventura County, California, in cones of *Pinus monophylla*. Length, 2.95–3.20 mm. Length, female type, 2.95 mm.; Ventura County, California, in *Pinus monophylla*, June 5, 1904, author, collector; Hopk. U. S., No. 2784. Type, Cat. No. 7474, U. S. N. M.

C. monophyllae, sp. nov.

Elytra with punctures of dorsal area coarse, impressed.

Dull black. Boulder and Manitou, Colorado, in cones of *Pinus flexilis*. Length 2.95–3.30 mm. Length, female type, 3.15 mm.; Mount Manitou, Colorado, in *Pinus flexilis*, January 25, 1914, W. D. Edmonston, collector; Hopk. U. S., No. 12400a. Type, Cat. No. 7475, U. S. N. M. . . . . **C. flexilis,** sp. nov.

SECTION a4

Black, shining; declivity with interspace 1 smooth. Northern California and southern Oregon, in cones of *Pinus lambertiana*. Length 2.85–3.95 mm. Length, female type, 3.50 mm.; Hilt, California, in *Pinus lambertiana*, September 20, 1913, P. D. Sergent, collector; Hopk. U. S., No. 10833a2. Type, Cat. No. 7478, U. S. N. M.

C. lambertianae, sp. nov.

ENTOMOLOGY.—*Correction of the misuse of the generic name Musca, with description of two new genera.* CHARLES H. T. TOWNSEND, Bureau of Entomology.

For almost a century the generic name Musca has, by misuse, been perverted from its rightful application. It is, nomenclatorially, one of the most important in the order of flies, or Diptera, the superfamily name Muscoidea being derived from it; hence, the correction of its misuse is especially important. The present paper deals with the proper application of the name and includes also descriptions of two new muscoid genera.

In 1810 Latreille[1] designated *Musca vomitoria* F. (=*Musca vomitoria* L.)[2] as type of the genus *Musca*. The designation is valid and can not consistently be set aside. Calliphora RD.[3] (1830) falls to

[1] Consid. 444.

[2] Bezzi & Stein (Kat. Pal. Dipt., 1907) indicate *Musca vomitoria* F. as a synonym of *Musca mortuorum* L. This is manifestly incorrect. Both the description and the bibliographic references given by Fabricius under *vomitoria* fix his species as *vomitoria* L. It must be pointed out that Latreille, in designating genotypes, customarily accredited Linnean species to Fabricius when such had been treated by the latter author.

[3] Myod. 433.

Musca; its type is *Musca vomitoria* RD. (nec. L.) = *Musca erythrocephala* Meigen, which species is congeneric with *vomitoria* L.)

Musca domestica L. and the species that have long been classed with it under the name Musca require fresh generic reference. At least three genera have been confused here, outside of Byomya and Plaxemya. The type of Plaxemya is *Musca vitripennis* Meigen, according to well-established synonymy. *Musca violacea* RD.[4] is hereby designated as the genotype of Byomya RD. (1830).[5]

Eumusca Townsend (1911) was founded on *Musca corvina* F. (restricted). The new genus Promusca is here erected for *Musca domestica* L., and the new genus Viviparomusca for *Musca bezzii* Patton & Cragg. *Musca tempestiva* Fallen is not typical of Promusca on external adult characters. It may form an atypical subgenus under Promusca, provided reproductive and early-stage characters are found to agree. Credit belongs to Portchinski[6] for suggesting, from the reproductive standpoint, some thirty years ago, the distinctness of the genotypes of Promusca, Eumusca, and Viviparomusca.

Promusca Townsend, gen. nov.

Genotype, *Musca domestica* Linné, Syst. Nat., ed. 10, no. 54. 1758.

The genus is to be distinguished from all the forms hitherto confused with it by the frontalia of female widening out to fill practically or nearly the whole front, and the eyes of male being widely separated. There are about sixty to eighty ovarioles in each ovary. The uterovagina is provided anteriorly with a pair of inflatable pouches or sacs named by Hewitt the accessory copulatory vesicles. Small macrotype, subcylindrical, unpediceled, unmodified and unincubated eggs are deposited. The ovaries mature simultaneously an egg for each ovariole, the whole product being normally ejected by the fly during one oviposition period. Puparium reddish-brown.

[4] Ibid. 393.

[5] Coquillett's designation (Type Spp. No. Amer. Dipt., 1910) of *Musca tempestiva* Fallen as type of Byomya is invalid, since he mentions by name no originally included species. Were we to accept as valid a designation of an originally included species by number with omission of the name, the designation in question would still remain invalid since it designates two of the originally included species. The use of the term "supposed species" does not affect the status of the case. The logical interpretation of the International Code is that one, and only one, of the originally included names of species can be validly designated as genotype, since this is the only course that can insure stable results. Synonymy is always subject to revision. Two names supposed to be synonymous may at any time prove to be distinct.

[6] Hor. Soc. Ent. Ross. **19**: 210–244. 1885.

EUMUSCA Townsend

Genotype, *Musca corvina* Fab.; Towns. restr., Proc. Entom. Soc. Washington, **13**: 167–170. 1911.

Syn. *Musca corvina* F.; Port., 1885–1892 (form depositing two dozen large eggs with pedicel).

Musca ovipara Port., Bur. Entom. Comm. Sc. Minist. Agr. St. Petersburg, **8**, No. 8: 13, footnote. 1910.

Musca corvina F.; Schnabl & Dziedz., Die Anthomyid. 128. 1911.

Parafacialia of female about one and one-half times as wide as third antennal joint, slightly narrowing below; those of male slightly widening below. Parafrontalia of female narrowest in middle, a little over half the width of frontalia at that point. Cheeks of male less than one-third eye-height, those of female not much over two-sevenths of same. Palpi of both sexes only faintly thickened apically, not flattened. Both sexes with only one pair of weak ocellars. Front of female distinctly less than eye-width. Only one discal pair of scutellars in both sexes. Penultimate joint of hind tarsi in both sexes hardly or but slightly longer than broad, the tarsal joints in general shortened. Male claws not heavy, strongly curved, slightly longer than last tarsal joint. Vein M_1 hardly at all or only faintly bent in after origin.

This genus has from one to two dozen ovarioles in each ovary. The uterovagina is without copulatory vesicles, so far as known. The eggs are large macrotype, subcylindrical, with long petiole. The whole product of both ovaries, being one egg for each ovariole, is apparently deposited at one oviposition period. Puparium white.

Musca pattoni Austen, *M. gibsoni* Patton & Cragg, and *M. convexifrons* Thoms. appear to belong in this genus, either as typical or as atypical forms.

Viviparomusca Townsend, gen. nov.

Genotype, *Musca bezzii* Patton & Cragg, Indian Journ. Med. Research, **1**: 9–14, *pls. 4 and 5*. 1913.

Differs from Eumusca as follows: Parafacialia of female very broad, equilateral, fully twice as wide as third antennal joint; those of male much narrower above, broadening conspicuously below. Parafrontalia of female in middle fully three-fourths the width of frontalia at same point. Cheeks of male over one-third eye-height, those of female about two-fifths same. Palpi of female much widened and flattened apically, those of male distinctly enlarged at tip but not much flattened. Female with three or four pairs of rather strong ocellar bristles, male with weak ones behind the front pair. Front of female in middle greater than eye-width. Two discal pairs of macrochaetae on scutellum. Penultimate joint of male hind tarsi fully twice as long as wide, the tarsal joints in general elongate rather than shortened. Male

claws long and strong, those of front and middle legs fully as long as last tarsal joint. Vein M_1 usually deeply bent in after origin.

This genus is remarkable for having practically the same type of female reproductive system as Glossina. There is only one ovariole in each ovary. The ovaries mature an egg alternately; one at a time being hatched, and maggot carried to third stage, in the uterus. The uterus is merely the much distended uterovagina, functioning as uterus; it bears no copulatory vesicles anteriorly. Puparium dirty-gray to yellowish.

Musca larvipara Portchinski[7] (syn. *Musca corvinoides* Schnabl & Dziedz.[8]) evidently belongs to this genus.

ANTHROPOLOGY.—*Prehistoric cultural centers in the West Indies.*[1] J. WALTER FEWKES, Bureau of Ethnology.

When the West Indies were discovered by Europeans the inhabitants of these islands were ignorant of the metals, iron and bronze, which have played such an important part in elevating the condition of prehistoric man in the Old World. Stone, clay, wood, bone, and shell were employed by the natives for utensils and implements; gold and copper for ceremonial purposes or for personal decoration. The Precolumbian aborigines of the West Indies, like those of the rest of America, were practically in what Professor Hoernes has aptly called the infancy of our race culture, to which the name Stone Age is commonly applied.

This period of race history seems to have been universal; it was nowhere of brief duration. Successive steps in cultural advancement were slow and in certain localities were retarded by unfavorable environmental conditions.

It has been estimated that the Stone Age in the Old World lasted from the year 100,000 to 5000 B.C.[2] The American Indian was practically in the Stone Age when he was discovered at the close of the 15th century, and the inhabitants of a few of the Polynesian Islands were still living in this epoch a little over a century ago. There is every reason to suppose that the

[7] Bur. Ent. Comm. Sc. Minist. Agr. St. Petersburg, **8**, no. 8: 13, footnote. 1910.

[8] Die Anthomyid. 128. 1911.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Practically another way of saying that the length of the Stone Age far exceeded the age of metals.

parentage of the American Indian dates as far back as that of the Europe-Asian man, provided both sprang from the same original source. It is known from evidences drawn from differences in implements that during the protracted Stone Age epoch man in Europe passed through distinct phases, which have been designated the Earliest, the Old, and the New stone epochs, before he entered that of metals. The American Indian had developed into the New or polished Stone Age when he came to America, and had not progressed beyond it when America was discovered by Columbus.

Although the Stone Age still survived in America when it was discovered, this epoch in the Old World had long before been superseded by one of metals, showing that the Age of Stone in the Old and New Worlds does not correspond in time; when the New World was discovered Europe had been in possession of metal implements for several thousand years. The highest development of stone technic, other things being equal, would naturally be looked for where it had been practised the longest time, and it is to be expected that the prehistoric stone objects found in America would be superior to the European, known to have been made before the discovery of bronze and iron.

Individual specimens of stone implements from the Old and New Worlds are so similar in form and technic that it is very difficult to determine which continent can show the better examples, but comparing the majority of implements from the Stone Age in America with those made before the discovery of bronze and iron now exhibited in Europe, it has been found that the former are, as a rule, superior to the latter. In Stone Age architecture we find a like superiority. The buildings constructed in the American Stone Age excel those of the same epoch in Europe, as will appear when we compare the stately temples of Peru, Yucatan, or Central America with the megalithic monuments and other buildings ascribed to the latest Stone Age of Europe.[3]

[3] I have based my judgment on the probable form and character of the ancient houses of the Stone Age in Europe, from "house urns" or burial urns shaped like houses, or from the reconstructions made of walls as indicated by post holes and floors. These buildings of the European Stone Age were certainly inferior to those of the same epoch in America.

Character and decoration of pottery is also a fair indication of cultural conditions reached in the Stone Age in different regions of the globe. The ceramics of this epoch in America reached a higher development than those of the polished Stone Age of the Old World, as may be readily seen by comparisons of the beautiful prehistoric American Stone Age pottery and that of man before the use of metals in the Old World.[4]

It thus appears that, if we base cultural advancement on pottery or house building, America had reached a higher stage of development than Europe, even though man in the former was ignorant of the metals, bronze and iron. The implication is that the human race, found in America in 1500 A.D., had lived in a Stone Age longer than man in Europe, where metals had been introduced fully 6000 years before Columbus.

The implements found in the West Indies are among the highest developed examples of this Stone Age. Many of them are the most perfect of their kind and rank with the polished stones of Polynesia, of Africa and Asia. In architecture, the branch of the American race inhabiting the West Indies in prehistoric times had not made great progress, although the cognate ceramic art was well developed.

While there is little in prehistoric America to show a serial succession of stone implements based on method of manufacture, as indicated by chipping, polishing, or other superficial characters, the variations in their forms are great. They indicate geographical rather than historical cultural distribution. Certain characteristic forms of stone artifacts are confined to certain areas, but these characteristics are not of such a kind as to make it difficult for us to readily arrange them in a sequence. The first step to take in explanation of different types of stone implements is naturally to define the areas that are typical.[5]

[4] These examples show the weakness of relying solely on stone, bronze and iron in classification and the futility of basing the degree of human culture on any one form of artifacts.

[5] The culture historian is concerned with the distribution of archaeological objects in time and space or in history and geography. It is for the geographer to interpret geography in relation to history and of the historian to translate history by the interpretation of the geographer.

While the different known types of stone objects found in the West Indies may be considered geographically rather than historically, this manner of assembling specimens in large collections brings out many facts which will make it possible later to determine a definite chronology, and to associate types of implements with local conditions, thus affording an instructive study of the interrelations of environment and human culture.

We can believe that certain of the stone implements found on these islands are old, but it cannot be proved that the oldest of them extend back to the earliest polished stone epoch. Stone implements made by chipping, or those having unpolished surfaces, are rare in the West Indies; they have not been reported in sufficient numbers to enable us to say that they indicate the former existence in these islands of an epoch when chipped implements were the only ones employed. A few chipped axes have been reported from Santo Domingo and other islands, but neither there nor in other islands are the flint chips numerous enough to afford conclusive proofs of an epoch, notwithstanding these implements and their chips closely resemble similar objects picked up on the sites of work shops in the Old World.

The discoverers of the West Indies early recognized that the aborigines of different islands differed in their mode of life, their culture, and their language. In early accounts we find two groups designated as Arawak and Carib, accordingly as their life was agricultural or nomadic. It was stated by the early travelers that these groups inhabited different islands, the former being assigned to the Greater Antilles, the latter to the Lesser.

The large collection of artifacts characteristic of the aborigines of the West Indies now available shows that the stone tools, pottery, and other objects found on the islands inhabited by the Caribs are radically different from those from islands on which the so-called Arawaks lived. Students of prehistory did not at first connect this difference with any racial dissimilarity, but ascribed all these implements to Caribs. This conclusion does not necessarily follow, for it fails to take into account the significant fact that the stone objects found on the so-called Carib

islands may have been made by a people inhabiting them before the Caribs came. Moreover, this interpretation does not give sufficient weight to the evidence furnished by the implements themselves, for they imply a culture quite different from that of the Caribs as made known by historical accounts, as flourishing at an earlier date on the Carib islands. In other words, there is good evidence of a prehistoric race inhabiting the Lesser Antilles before the arrival of the Europeans.

One characteristic of the prehistoric objects found on the islands inhabited by Caribs when discovered may be mentioned in this connection. It is well known that the Arawak, like all agricultural peoples, are great potters, and that the ancient Caribs, like nomads, from necessity were not. The two races probably preserved these characteristics in the West Indies; and the fact that we find pottery objects of high excellence on all the islands inhabited by the Caribs leads to the natural inference that they were made by a people allied to the Arawak who anciently lived on these same islands.

Archæological remains left by the aborigines of the West Indies reveal three cultural epochs, grading into each other, which may indicate a sequence in time or distinct cultural stages. These epochs were the cave dwellers, the agriculturalists, and the Caribs. The most primitive culture is represented by objects found in the floors of caves or in the numerous shellheaps scattered from Cuba to Trinidad. A second stage is more advanced and is agricultural in nature, represented on all the islands but surviving at the time of discovery on the larger—Cuba, Hayti, and Porto Rico; while the third, or Carib stage, had replaced the agricultural in certain of the Lesser Antilles, especially on the chain of volcanic islands extending from Guadeloupe to Grenada.

Although the three stages above mentioned are supposed to follow each other chronologically, not one of them had completely died out when Columbus discovered America. The cave dwellers still survived in western Cuba and in Hayti, and according to some authorities they spoke a characteristic lan-

guage. The Arawak inhabited Porto Rico, Hayti, Cuba, Jamaica, and the Bahamas.

The customs of the aborigines who left the great sheelheaps found throughout the West Indies were apparently not very different from those of the natives of prehistoric Florida, or northern South America. These people, essentially fishermen, lived on fishes, mollusks, or crabs, eking out their dietary with turtles, birds, and other game captured along the shores; fruits and roots were also probably collected and eaten, but their main food came from cultivated crops of yuca planted in the neighborhood of their settlements. The nature of their food supply confined them to the seashore or to banks of rivers where village sites occur in numbers. It is probable that the shellheap people of the West Indies were likewise cave dwellers and resorted at times to rock shelters for shelter or protection. We know from excavations in caverns that they buried their dead in these caves which later came to have a religious or ceremonial significance.

We may suppose that a life devoted to fishing would make men good sailors, and it is probable that the prehistoric Antilleans manufactured seaworthy canoes, hollowing out logs of wood with the live ember and the stone axe. It is also evident from objects found in the floors of caves that the women of this epoch manufactured pottery, and as reptilean figures in relief or effigy vases representing this animal occur constantly, we may suppose that some reptile as the iguana or turtle was highly prized for food. Some of the bone needles, whistles, and ornaments of shell or wood found in shellheaps show that those who camped in the neighborhood were advanced in culture, while other objects found in the West Indian shellheaps are, so far as technic goes, equal to that of the highest of the Stone Age culture. It is probable that this form of culture reaches back to a very early date in culture development.

One important consideration presents itself in relation to the shellheap life in the West Indies as compared with that of the shellheaps in Florida and Guiana in South America. From the very existence of the shellheap culture on the continents and con-

necting islands they would seem to shed light on the earliest migrations of West Indian aborigines. Unfortunately, however, the objects manufactured by all primitive people in this stage are so crude that they are not distinctive; there is often a parallelism in their work. For example, pottery from widely separated regions often bears identical symbols, even where the people who manufactured it have had no cultural connection. Consequently, although we find certain common features in decorated coastal pottery of Florida and that of Porto Rico, this similarity implies rather than proves cultural contact.

The highest prehistoric culture attained in the West Indies was an agricultural one. It was based on the cultivation of the yuca (*Manihot manihot*), a poisonous root out of which was prepared a meal, from which the so-called cassava bread was made. At the time of the discovery the cultivation of this plant had attained its greatest development and so completely had it developed that Porto Rico and Hayti are said to have been practically covered with farms of this plant. In fact, when sorely pressed by the Spaniards to furnish them gold for tribute one of the caciques offered to cultivate, for the conquerors, a yuca farm extending across the island of Hayti. Both Porto Rico and Hayti appear to have been densely populated, and the failure of the population to advance into a higher stage of development was limited by the perishable character of the root or food plant cultivated. Corn and other cereals[6] were not extensively used and there was no domesticated animal. It is evident that this culture was built on a root food supply which was clearly a product of environment, and on account of this dependence merits careful study by the culture historian and anthropo-geographer.

The development of this culture varies on different islands or groups of islands, forming cultural centers of which the following can be recognized by the character of the pottery: (1)

[6] Corn (*Zea mays*) was introduced into the West Indies as a food plant shortly before the advent of the Spaniards. If sufficient time had elapsed it would have replaced this unique form of cultural development based on root agriculture, unless as in the Lesser Antilles it had been destroyed by Caribs who were pressing in upon it with such force that it could not survive.

Porto Rico, (2) Jamaica, (3) eastern Cuba and Bahamas, (4) St. Kitts, (5) St. Vincent, (6) Barbados, (7) Trinidad. The differences in artifacts characteristic of these culture centers of the Antilles are sometimes small; thus, the Porto Rico area, which includes also Hayti and Santo Domingo on the one side and the Danish islands on the other, is clearly allied to the eastern Cuba and Bahama area. In the former we have the three types of stone implements—stone collars, elbow stones, and three pointed idols—none of which has yet been found in Cuba, the Bahamas, or Jamaica. Pottery from these islands, except the last mentioned, bears rectilinear or curved lines ending in enlargements,[7] a decorative feature which is absent in Jamaica. This feature does not occur in the Lesser Antilles from St. Thomas to Trinidad, where four different regions of decorated pottery can be differentiated.

An adequate account of the characteristic features that differentiate the seven Antillean culture centers of the West Indies would swell this article to undue proportions, but will be considered at length in a report on the magnificent Heye collection of West Indian antiquities.

Lest the author may be thought to have confused the ancestral cavern culture with a secondary cave life due to an adaptation to environment, it may be added that the former is that discussed in this article.

[7] This characteristic feature of Porto Rican pottery decoration appears on characteristic pottery found by Mr. Clarence Moore in mounds of northern Florida.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 294th meeting was held in the lecture room of the Cosmos Club on March 24, 1915.

SYMPOSIUM ON THE FACTORS PRODUCING CHANGE IN POSITION OF STRAND-LINE DURING PLEISTOCENE AND POST-PLEISTOCENE

T. WAYLAND VAUGHAN: *Introductory remarks.* Before introducing the speakers, the President of the Society called attention to the geologic importance of the factors producing change in the position of the strand-line, and stated that the subject is perhaps brought more forcibly to the consciousness of those who are studying present-day shore lines. As instances of phenomena which demand explanation, the succession of terraces and the general character of the shore line within the Coastal Plain of the eastern United States between New Jersey and Mexico were mentioned. The so-called "coral-reef" problem was cited as furnishing other instances of phenomena which have not been satisfactorily explained.

It appears safe to say that the coral-reef platforms are due to planation processes, operating partly above and partly below sea-level. It has been possible to make correlations in some of the West Indies between the length of geologic time planation processes have been operative and the width of the platform. The deduction that such platforms were formed and have been submerged is so firmly established that it may be accounted a geologic fact. How were they submerged, why do some show vibratory oscillation while others do not, why has there been in some areas marked tilting or warping while in other areas such phenomena are not exhibited, why does the depth of water in the principal atoll and barrier lagoons of the Pacific so nearly accord, and why is the depth on the extensive platforms in the Caribbean Sea and around many of the West Indian Islands the same as on similar platforms in the Pacific? Are there causes of world-wide as well as others of only local effect? If causes of the two classes are operative, how much of the resultant effect is to be assigned to each? The ultimate answer to these questions largely depends upon detailed investigations of numerous tropical and sub-tropical areas, but definite results can not be expected unless the fundamental principles involved have been ascertained, and unless these principles are properly

applied in the elucidation of the phenomena. After referring to the important work of American geologists, geodesists, mathematicians, and physicists in contributing to our knowledge of the fundamentals of geology, he introduced the speakers of the evening.

JOSEPH BARRELL, *Factors in strand line movement and their results during Pleistocene and post-Pleistocene.* (Published in brief in Journ. Wash. Acad. Sci., **5**: 413–420. 1915.)

W. J. HUMPHREYS, *Changes of sea-level due to changes of ocean volume.* Obviously anything that changes the amount of water in the oceans also changes the sea-level at all parts of the world. Hence to this extent changes in the positions of strand lines are not referable to differential crustal movements. It will be interesting, therefore, to consider how greatly and by what means the amount of water in the ocean probably has varied in recent geologic times. There have been at least three factors effecting such changes: (*a*) Annual accumulation and melting of snows,—negligible in its effect on sea-level; (*b*) change in vapor content of the atmosphere due to differences in world temperatures—also negligible in its effect on sea-level; (*c*) epochal changes in the amount of glaciation—effect on sea-level probably very important. It will be convenient to consider these factors separately:

a.—During northern winters snow accumulates to a greater or less extent over, roughly, one-tenth of the earth's surface, or over all land areas beyond latitude 40° N. Between this latitude and 60° N. the annual precipitation averages about 500 mm., the largest portion occurring during summer. At higher latitudes the precipitation appears to be less. A snow accumulation, therefore, equivalent to 50 mm. of water over all this area would seem to be a conservative estimate. If this estimate is approximately correct, it follows, allowing for the 5 to 12 ratio of land to water, that northern snows lower the sea-level some 7 mm., an amount which, geologically, is negligible. This assumes, though it is only approximately true, that the northern and southern hemispheres compensate each other in their temperature effects on the volume of the oceans and on the moisture content of the atmosphere.

b.—If we assume that the average surface temperature of the world is 5°C. warmer now than it was at the time of the last maximum glaciation, it follows that the atmosphere must now hold more water vapor than then to the extent of a layer of water about 7 mm. deep. This would imply that from this effect alone the ocean level is about 10 mm. lower than it otherwise would be. On the other hand, the corresponding temperature change of the oceans themselves has produced an opposite effect, probably several (10, perhaps) times as great.

c.—The fact that the average thickness of the ice-cap during the last glaciation can be only roughly estimated renders any calculation of its effect on ocean level correspondingly doubtful. It does not seem probable, however, that they could have averaged much if any thicker than the present caps of Greenland and of Antarctica, which

a number of good observers have estimated to be about 1000 meters. Taking this value and assuming the deglaciated area to be equal to one-fifteenth the area of the ocean, or, roughly, twice the glaciated area of North America, we estimate the change in sea-level to have been about 67 meters. As already stated, this is only an estimated change, but perhaps it is a conservative estimate.

In this connection it is interesting to note that the complete deglaciation of Greenland and Antarctica, if their ice caps average 1000 meters thick, would raise the sea-level about 40 meters, of which Greenland would contribute about 6 and Antarctica 34. Presumably these changes in sea-level which must have occurred as a result of glaciation and deglaciation are best preserved in equatorial regions. The change of load was more evenly distributed here than in the higher latitudes, and therefore local warping was probably much less.

Discussion: President WOODWARD of the Carnegie Institution of Washington had been expected to lead the discussion of the papers which had been presented, but was unable to be present. President VAUGHAN called upon Dr. WILLIAM BOWIE of the Coast and Geodetic Survey for some remarks. Dr. BOWIE said that in his opinion the oscillations of the strand-line spoken of by Professor BARRELL, involving movements over large areas, could hardly be accounted for by the theory of isostatic adjustment. Deposition of sediment on ocean floors, continued over long periods of time, would be expected to cause eventually a sinking of the floor on which they rested, and islands which were surrounded by such areas of loading would naturally participate in the downward movement; but a subsequent rise or oscillation of level, such as had frequently been noted, could not be explained by isostasy, and other physical and chemical forces must be invoked. Likewise the unloading of land areas by erosion would be expected to result in upward movements, but oscillations could not be explained as effects of isostatic adjustment. He thought that as regards this question as a whole geodesists should not be expected to advance theories in explanation of the movements which geologists have recognized. The primary purpose of the geodetic work in making measurements of gravity is to determine the shape of the geoid. The results thus obtained give quantitative data which geologists may employ in explaining the phenomena observed.

J. W. SPENCER spoke of the great submergences which he had formerly believed were shown in the West Indian region. He was now somewhat doubtful about the evidence on this matter, but was more certain regarding the region of the Great Lakes. He had traced several low terraces around Lake Ontario, and their parallelism with the present water-surface showed that the region had undergone no deformation during the time taken by the St. Lawrence River to cut its channel 15–20 feet deeper. He spoke also of the work of D. W. JOHNSON as tending to establish the lack of recent deformation along the Atlantic Coast. At the same time various observers have found evi-

dences of the presence of platforms submerged to a great depth along several of the continents—one at 3000 feet and the trace of another at 6000 feet. Spencer did not believe that the phenomena in Norway justified De Geer's estimate of 10,000 years for the period which had elapsed since the end of the ice-age. There has been too much subsequent erosion. From the phenomena shown at Niagara 40,000 years seemed a probable estimate.

Bailey Willis spoke of the delta plain of the Yellow River in China. He did not believe that the explanation which some had advanced, attributing its origin to submarine planation, was correct. He believed that it has been maintained as a very flat plain because of subsidence of its inner portion, and that therefore the low gradient is to be attributed to warping. The delta of the Amazon likewise has a very low gradient in spite of the great quantities of sediment which are being deposited upon it. Here also the phenomena must be explained by postulating a subsiding area. Along the Argentine coast there are evidences of warping on an extensive scale. Such phenomena cause a rise in one area and sinking in another, and complicate the strand-line problem.

Arthur Keith expressed his agreement with Professor Barrell in considering that there are evidences of many successive terraces along the Atlantic Coast, but disagreed with the view that attributed to them a submarine origin. He asked for Barrell's criteria. Barrell replied that the terraces along the broad river-valleys were, in his belief, subaerial, and were to be attributed to river erosion at the periods corresponding to stages of sea-level at which marine planation had formed the platforms whose inner margins were essentially parallel to the present coast-line. The evidence regarding the marine origin of the latter terraces was too extensive for presentation at the moment, but would appear later in published form.

Sidney Paige inquired as to Barrell's reasons for believing that along the Atlantic coast an oscillatory movement of the strand-line had occurred just previous to the development of each platform. Barrell replied that in every case the coast-line was very sinuous at the time of platform development. Analysis of the features showed that just prior to the long stand of the sea represented by each platform there had been an elevatory movement, resulting in the carving of stream-valleys, followed by a slight re-submergence, with drowning of the valleys; and a long stand, resulting in the development of a submarine plain. President Vaughan thought that all those who had been engaged on coastal plain work would be in essential accord with Barrell's views.

E. W. Shaw spoke of the evidence of movements in the southern coastal plain region during Quaternary time. The effects observed could not be explained by river-work, as Chamberlain and Salisbury had attempted to do. President Vaughan spoke of the great importance of the study of the nature and character of submarine profiles which Barrell had made.

C. N. Fenner, *Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 542d meeting was held in the Assembly Hall of the Cosmos Club, Saturday, May 15, 1915, with President BARTSCH in the chair and 43 persons present.

On recommendation of the Council, FRANCIS N. BALCH, Boston, Massachusetts, and ERNEST P. WALKER, Wrangell, Alaska, were elected to active membership.

Under heading exhibition of specimens, L. O. HOWARD showed lantern slides from photographs of a moth, *Ceratomia amyntor*, bringing out its protective coloration while at rest on bark.

The first paper of the regular program was by C. H. T. TOWNSEND, *Two years' investigation in Peru of verruga and its insect transmission.*

The four stages of verruga are defined as *incubative, fever. quiescent* and *eruptive.* The most important symptom of the fever stage is the presence of the bacilliform bodies (*Bartonia bacilliformis* Strong et al.) in the erythrocytes. The histology of the eruptive papules is not yet sufficiently defined for positive diagnosis in the absence of the clinical history, but its chief feature is a marked proliferation of angioblasts.

Verrugas Canyon is the best known and probably one of the strongest endemic foci of the disease. Extended investigations were carried on there both day and night at all seasons of the year. The result was an ecological demonstration of *Phlebotomus verrucarum* Townsend as the vector of the disease. This demonstration is built on the unique etiological conditions already known. Verruga can be acquired only by direct inoculation into the blood, is only contracted at night, is confined to very restricted areas within which it is almost universally contracted at any time of year by non-immunes who remain from 7 to 10 consecutive nights. These conditions necessitate a blood-sucking vector which is abundant, active only at night but throughout the year, and whose distribution is coterminous with the infested areas. The above *Phlebotomus* is the only bloodsucker which meets these requirements.

Clinical verification of the vector was obtained from the history of numerous cases of verruga observed by Dr. Townsend. Transmissional demonstration in laboratory animals lacked completeness only by reason of the impossibility of positively diagnosing verruga eruptive tissue, papules having been produced in animals by injection of the crushed *Phlebotomus.*

A biting experiment was carried through, resulting in what appeared to be a light infection. This was the case of MCGUIRE, who exhibited all the symptoms but with a paucity of the bacilliform bodies in the erythrocytes. Papules appeared sparingly after the subject had been discharged. Dr. Townsend's assistant, Mr. NICHOLSON, accidentally received many *Phlebotomus* bites, thereby furnishing a clean experiment with two checks. The checks were Dr. Townsend and his assistant, Mr. RUST, both of whom were subjected to exactly the same conditions as Mr. Nicholson except that they did not receive the

bites. They did not contract the disease, while Mr. Nicholson showed a well marked case, with both the bacilliform bodies in the erythrocytes and the characteristic eruption.

Lizards were suggested as a possible reservoir of verruga, from the fact that were the only vertebrates aside from man, domestic or wild, at Verrugas Canyon, whose blood showed bacilliform bodies. The lizards inhabit the numerous loose rock walls which everywhere in the Andean region take the place of fences, and these are the favorite diurnal hiding places of the *Phlebotomus* swarms. Injection of the lizard blood into guinea-pigs resulted in similar bodies in the erythrocytes of the injected animal.

The unity of verruga was insisted on, in opposition to the thesis of Dr. R. P. STRONG and his associates. The entire Peruvian medical fraternity concur in this view. The facts given in support of it appear to be irreconcilable with the opposite view.

Prophylactic measures were outlined; and the remarkably perfect climatic conditions of the verruga zones, unequalled for sanatoria, were dwelt on. (*Author's abstract.*)

Dr. TOWNSEND's paper, which will be published in full in the *American Journal of Tropical Diseases and Preventive Medicine*, was illustrated by lantern slides made from photographs of *Bartonia bacilliformis*, of clinical cases, of the micro-pathology, of the *Phlebotomus*, and of Verrugas Canyon, etc. It was discussed by Admiral C. W. BAIRD and Medical Inspector H. E. AMES.

The second paper was by W. DWIGHT PIERCE, *The uses of weevils and weevil products in food and medicine.* Mr. Pierce described in particular the trehala manna of Syria which is the cocoon of the large weevil known as *Larinus nidificans.* These cocoons are used by the natives as a food similar to tapioca and are commonly sold in the drug stores for use in making a decoction said to be efficacious against bronchial catarrh. The cocoons are made by an abdominal excretion of the larvae and contain a large percentage of sugar known as trehalose, as well as a carbohydrate, a little gum, and a small amount of inorganic mineral matter. (*Author's abstract.*)

Specimens of the trehala manna and of the weevil were exhibited.

The third communication was by L. O. HOWARD, *Some observations on mosquitoes and house flies.* DR. HOWARD spoke of the work which is being done in New Jersey against mosquitoes, describing the organization of county inspectors which was effected at Atlantic City in February at an "antimosquito convention." He showed a series of lantern slides illustrating the very effective work done by the Essex County Commission in the vicinity of Newark, New Jersey. He then spoke of the work done by Mr. HUTCHINSON, of the Bureau of Entomology, in regard to trapping the maggots of the house-fly, illustrating his remarks with lantern slides showing a large out-door maggot trap in use during the summer of 1914 under Mr. Hutchinson's directions at College Park, Maryland. The illustrations in question appear in U. S. Department of Agriculture Bulletin No. 200. (*Author's abstract.*)

The last communication was by A. L. QUAINTANCE, *Remarks on some little known insect depredators.* Mr. QUAINTANCE called attention to certain species of insects which have but recently come into prominence as of economic importance and to other species which, although long known to entomologists as occasional pests, have recently attracted attention in view of local outbreaks. A species of Jassidae, *Typhlocyba obliqua,* is at the present time seriously destructive to apples in portions of the Ozark mountain region and in Kansas. These insects occurred in countless numbers in some orchards, infesting the lower surface of the leaves, causing the foliage to drop with subsequent injury to the fruit crop and the trees. A tineid insect of the genus *Marmara* was reported to have caused a good deal of injury to certain apple orchards in Albemarle County, Virginia. The caterpillar makes long serpentine mines under the skin of the apple, resulting in blemishes. The keeping quality of the fruit is also lessened. The common walking stick, *Diapheromera femorata,* while often the cause of more or less local defoliation in forests, occasionally becomes a serious pest in orchards, especially in orchards adjacent to woodlands. These walking sticks have recently been complained of on account of important injuries to apple and peach orchards in Virginia and West Virginia. *Rhabdopterus picipes,* a chrysomelid beetle, has recently been discovered as damaging cranberries. The insect is a near relative of the grape root worm, *Fidia viticida,* and the larvae work on the roots of the cranberry, feeding principally on the fibrous roots, but also stripping the bark from the older roots. Investigations of the insect by Mr. H. B. SCAMMELL indicate that it is restricted in cranberry bogs to the higher and sandier soils. *Nezara hilaris,* one of the stink bugs, and long known to feed on vegetation of various sorts, has recently become very abundant and destructive to peaches in the Marblehead district in northern Ohio. These plant bugs in feeding insert their beaks in the developing fruits, causing the peaches to become knotty and misshapen as they grow, and many of which fall from the trees. *Parandra brunnea,* better known as the chestnut telephone borer, following investigations by Mr. SNYDER has been determined by Mr. FRED E. BROOKS to be very generally present in the heartwood of old apple trees and as a result of its work the trees are often so weakened that they are easily broken or blown over by winds. Various species of Cecidomyidae are known to be serious crop pests, as the sorghum midge, the pear midge, etc. A new midge pest, *Contarina johnsoni,* has during recent years come into prominence on account of its injuries to grapes in the Chautauqua and Erie grape belts. The adults oviposit in the blossom buds, which may contain from 10 to 70 maggots, though the average number is much less. Many blossoms are thus destroyed, resulting in very ragged and imperfect bunches of grapes.

This paper was illustrated by lantern slides showing the insects and their work from photographs prepared mostly by Mr. J. H. PAINE.

At 10.15 the Society adjourned until October.

M. W. LYON, JR., *Recording Secretary.*

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 484th meeting of the Society, held March 2, 1915, in the Public Library, an address was given on *Confucianism, the State Religion of China*, by Mr. E. T. WILLIAMS, of the State Department, who spent 26 years in China and supplemented his personal observations by a study of the Institutes of the Manchu Dynasty and the Manual of the Ministry of Rites. The interpretation of the ritual he takes from the Chinese classics, particularly the Book of History and the Book of Rites. Confucianism for two thousand years has been the state religion of China. It existed long before Confucius was born, but is properly called by his name, since its sacred scriptures were in large part edited by him and he has become one of the chief objects of worship in the system. While the lofty character of its ethical teaching is characteristic, it is a mistake to say that Confucianism is merely a system of ethics. The teaching of the Book of Rites and the ceremonies observed in the offering of sacrifices to the Supreme Being and to lesser deities and saints, makes its religious character clear. By an edict in 1907 the Empress Dowager raised Confucius to equal rank with the Supreme Deity in the pantheon.

At the service in the temple of Confucius at the spring and autumn equinoxes, the worship of the sage does not consist merely in making obeisance before his tablet, as has sometimes been said, but in making offerings of incense and food, libations of wine (more properly, rice spirits), and sacrifices of oxen, sheep, and pigs, together with a burnt offering of silk. The worship is conducted by the chief official of the county. There are kneelings and prostrations and a chanting of hymns to the accompaniment of an orchestra consisting of a great variety of wind and stringed instruments, drums, bells, and musical stones. The services in the Temple of Heaven in Peking are held at the winter solstice. The Temple of Heaven is a large park situated in the southern suburb of the capital. It is enclosed by a strong wall and is divided into a number of courts. Even the Emperor could not enter the inner court except on foot. Within this court is a most holy place, the court of the altar. There has never been at any time in China more than one recognized altar to the Most High. The principal altar is of white marble and consists of three circular terraces. It is open to the sky, and the offerings made here are presented by the head of the state two hours before dawn on the longest night of the year. Three, and its multiple, nine, are the important numbers in the construction of the altar, while four and eight are those represented at the altar to the earth, north of the capital; for odd numbers belong to heaven and even ones to earth. Near the marble altar there is also an altar of burnt offerings constructed of green, glazed tiles. One young bullock, black and without blemish, was consumed on this altar as a sacrifice to Shangti. The Emperor, after donning his priestly robes, washed his hands and ascended the marble altar, facing the north. There he worshipped Shangti and his imperial ancestors. There are some striking analogies between this ritual and that of the ancient Hebrews.

Since the revolution of 1911 the state sacrifices have been quite generally suspended. Last September, however, President Yuan Shih-kai, participated in the worship of Confucius at the temple erected to him in Peking, and in December offered sacrifice to Shangti in the Temple of Heaven. The whole burnt offering heretofore sacrificed to Shangti was omitted and simple bows were substituted for the kotow. Sacrifices to ancestors are made by all classes in their homes at the winter solstice, and at eastertide all visit the family tombs and set out gifts of rice and wine.

The apparent failure of this religion to satisfy the longings of the human heart is shown by the popularity of Buddhism, particularly the modified form prevalent in China, which instead of Nirvana holds out the hope of immortality in the "Western Heaven." The restoration of the state religion by the President does not mean the abolition of religious liberty; for the Chinese government holds that, as Great Britain allows freedom of worship and yet supports one state church in England and another in Scotland, so China may have its official religion and yet grant toleration to other faiths.

DANIEL FOLKMAR, *Secretary.*